



PORTFOLIO AS AN ACTIVE LEARNING METHODOLOGY FOR THE STUDY OF THE ENDOCRINE SYSTEM

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ABSTRACT

The goal of this study was to use a portfolio regarding the physiology of the endocrine system for second-year medical students (n=125) as an active methodology in the teaching-learning process. Moreover, the portfolio was used as reference material for the cognitive monitoring test (CMT). The students were divided into groups and instructed to organize a portfolio with 7 cards containing 7 topics about the proposed subject. Later, the students answered two questions about the teaching methodology applied: 1) How did you evaluate the portfolio? 2) Did the activity aid in your learning process? Why? The results demonstrate that most students (92.8%) thought that the portfolio was effective teaching and learning tool while 7.2% of students reported that the methodology used was not important. The majority of the scores (76.05%) for the test were above 50% of the possible total score for the CMT (5.0 to 6.9) from the students that knew they would be allowed to consult portfolio. Additionally, the majority of the scores (92.6%) for test were above the course average (7.0) from the students that did not know they would be allowed to consult portfolio. In face of the results obtained from students' opinions and by analyzing the CMT scores, we can come to the conclusion that the use of the portfolio as an active methodology in the teaching-learning process for second-year medical students has encouraged the search for knowledge and has allowed for an active construction for learning about the endocrine system physiology, besides developing in each student the ability to debate and share the knowledge in the group and among groups.

KEYWORDS: Graduate Education, Active learning, Portfolio, Physiology, Endocrine system.

INTRODUCTION

In Brazil, and many other countries, there has been a discussion concerning the necessity for adjustments and changes in the medical training (Nair and Webster, 2010; Gomes and Rego, 2011). Medical education should no longer focus on technical ability as its one and only goal, despite its relative importance. Throughout the course of a medical education, other aspects should also be addressed, such the speed of information transfer, the use of information and communication technologies as management resources, continuing education, the ethics and the commitment to good citizenship (Gomes and Rego, 2011).

Generally, active learning is the process of engaging students in an activity that forces them to reflect upon ideas and how they are using those ideas. This method requires students to regularly assess their own degree of understanding and skill regarding certain concepts or problems in a particular discipline. Consequently, students are mentally, and often physically, engaged in their learning through activities that require information, gathering, thinking, and problem solving (Ghosh, 2007). This method prevents the simple transfer and repetition of knowledge between instructor and student. As Michael said "there is evidence that active learning, student-centered approaches to teaching physiology work, and they work better than more passive approaches. There is no single definitive experiment to prove this, nor can there be given the nature of the phenomena at work, but the very multiplicity of sources of evidence makes the arguments compelling" (Michael, 2006).

Studies prove that the transition from medical student to the recently graduated doctor is very stressful (Pitkala and Mantyranta, 2003; Luthy et al., 2004). Insufficient preparations during medical school and the lack of qualified support during the beginning of the professional activities are important factors that contribute to this stressful transition (Luthy et al., 2004). For that reason, activities such as using active methodologies in association with traditional strategies during medical education can positively impact student development because during their training they were constantly encourage to participate in the search and the construction of knowledge.

We employed active learning techniques in a typical physiology course that involved the nervous, endocrine, cardiovascular, respiratory, renal, digestive and reproductive systems. We initially used brainstorming followed by conceptual maps, question-and-answer games, dramas, memory games, puzzles (Marcondes et al., 2015) and portfolio creation as well as other activities such as seminars and practical classes using computer simulations.

The portfolio is a set of information (texts, pictures, diagrams, tables, charts, schemes, photos) produced by student over a certain period of time and on a particular subject. When this collection of information is well organized it becomes a great reference material for study as well as can be used as an evaluation tool. It promotes reflective development of the student, stimulates the conceptual enrichments process, and contributes to the self-construction of knowledge. Portfolios have long been used in nonclinical fields including education, arts, and architecture.

More recently, there has been a push to use portfolios across the continuum of medical education (Nagler et al., 2009). Portfolios have been used in medical education as a pedagogical tool with multiple implementations towards different goals (Buckely et al., 2009; Tochel et al., 2009). Some educational programs report using formative portfolios to encourage trainees to reflect on their learning (Rees and Sheard, 2004; Driessen et al., 2005), whereas others use cumulative portfolios to inform decisions of student promotion to further levels of study (Davis et al., 2001; Dannefer and Henson, 2007).

The goal of this study was to use a portfolio regarding the physiology of the endocrine system as an active study methodology, without evaluation intent, for second-year medical students. Later, the portfolio built by the groups was used as reference material for the cognitive monitoring test (CMT).

METHODS

Second year medical school students ($n = 125$; seventy-one students were warned before the CMT that would be allowed to consult the portfolio, and fifty-four students did not know they would be allowed to consult the portfolio) were randomly divided into groups of 4 students each. Each group was instructed to prepare a portfolio composed of 7 cards describing the following information for each hormone or group of hormone of interest: hormone classification (protein, peptide or steroid); hormone production site (endocrine gland, neuron, endocrine cell); main physiological mechanisms related to control of hormone secretion; hormone mechanism of action on target cells; main hormone regulated organic actions; hormone importance and clinical correlations, and lastly, two to three incomplete or incorrect sources of information found on the Internet.

The following hormones were assigned for each portfolio: 1 – Growth hormone (GH); 2 – Vasopressin or Antidiuretic hormone (ADH); 3 – Prolactin (PRL) and Oxytocin (OT); 4 – Thyrotropin-releasing hormone (TRH), Thyroid-stimulating hormone (TSH), Tetraiodothyronine (T_4) and Triiodothyronine (T_3); 5 – Parathyroid hormone (PTH), Calcitonin and Vitamin D_3 ; 6 – Insulin and Glucagon and 7 – Corticotropin-releasing hormone (CRH), Adrenocorticotrophic hormone (ACTH), Cortisol and Aldosterone.

The portfolio was organized into 7 cards, each of which contained the information listed above for each hormone or group of hormone. For example: Card 1 - Growth hormone: classification; production site; main mechanisms related to control of secretion; mechanisms of action; main organic actions; clinical correlations involving GH and incomplete or incorrect information found on the Internet.

Students were allowed to use the current literature of the field, clinical textbooks related to the theme of the clinical correlation, indexed journals and the Internet. The portfolio could include text, pictures, diagrams, tables and photos. The time available for the groups to prepare the portfolio included time spent in a physiology class over two weeks (12 hours), so that the activity would not conflict with the students' free time for studying and resting. The groups were encouraged to complete the portfolios during classroom time so that any questions could be quickly discussed with the teacher.

The CMT is one of the assessments we use in the medical school curriculum at our school. Four CMT are held during each semester of the course between the first and the eighth semesters. The CMT was held five days after students finish portfolios. On the day of the CMT, each two groups (each $n = 4$) were randomly combined into one ($n = 8$) and the students were allowed to use only one portfolio of either group for reference, except for groups that were not allowed to consult the portfolio (control groups): a control group for students that knew they would be allowed to consult the portfolio,

and a control group for students that did not know they would be allowed to consult the portfolio.

The CMT questions were created using the same criteria and questions that students had answered in other evaluation tests during the course. The questions (five open questions) were based on real clinical cases, focusing on the hormone physiology compiled on the portfolio cards. The time available for completing the CMT was four hours. Students were advised that a higher technical quality of answers was expected because the test was performed in groups and consultation with the portfolio was allowed, except for the control group.

The CMT scores achieved by the groups were separated into three sets: 0 to 4.9; 5.0 to 6.9 and 7.0 to 10.0. The scores were grouped together under this criteria to identify students with below 50% efficiency on the test (scores from 0 to 4.9), students whose efficiency was higher than 50% (from 5.0 to 6.9), yet below the course average of 7.0, and students whose efficiency was higher than the course average (scores from 7.0 to 10.0).

To provide students with feedback during the first class following the CMT, we reviewed the test questions with the students and asked them to discuss two questions related to portfolio usage: 1) How did you evaluate the portfolio? 2) Did the activity aid in your learning process? Why? The questions were answered individually and the papers were handed to the teacher.

During the two weeks after the activity, there were discussions with debates during the lecture concerning all hormones included in portfolios. Consequently, students discussed the physiology of the endocrine system prior to the theoretical classes.

Statistical analysis

Data from CMT scores were analyzed by one-way ANOVA for repeated measures and Tukey's test. Statistical analyses were performed using Sigma Stat (Systat Software, Point Richmond, CA, USA) with a significant level set at 5% ($P < 0.05$).

RESULTS

According to student responses regarding the portfolio, 92.8% ($n = 116$) of students believed the activity were important for their knowledge concerning the physiology of the endocrine system and 7.2% ($n = 9$) of students reported that the methodology used was not important.

Based on the CMT scores obtained from students that knew they would be allowed to consult portfolio, nine students (12.7%) scored 7.0 to 10.0 (average = 8.6) and fifty-four students (76.05%) scored 5.0 to 6.9 (average = 6.3). No student scored between 0 and 4.9, and eight students of the control group (11.26%) scored 5.0 to 6.9 (average = 5.2). A significantly greater number of students scored between 5.0 and 6.9 than did between 0 and 4.9 or 7.0 and 10.0 ($P < 0.05$). Based on the CMT scores obtained from students that did not know they would be allowed to consult portfolio, fifty students (92.6%) scored 7.0 to 10.0 (average = 8.9) and four students (7.4%) from the control group scored 5.0 to 6.9 (average = 5.1) ($P < 0.05$).

In addition to the questions posed to all students, the participants could make suggestions and criticize the use of the portfolio. Three positive points (93%) were repeatedly mentioned by many students: the active participation of the group members during portfolio preparation; the possibility to correlate physiology with other disciplines from the basic sciences, such as anatomy, cell biology and biochemistry; and the possibility to create group discussion during the CMT. Moreover, four negative reviews (46%) were mentioned by most students: the selection of the group members should not be random as students prefer to choose whom they work with; the time available for the creation of the portfolio should be longer; the content (topics) should be more concise; and finally, the portfolio should be discussed after each of the theoretical classes

concerning the proposed subject.

DISCUSSION

This study concerning the use of a portfolio as an active methodology in the teaching-learning process regarding endocrine system physiology for second-year medical school students has shown the portfolio to be a significant teaching resource. Physiology is considered as the basis of a rational medical practice (West, 2002). Understanding the mechanisms of the body requires a high level of integration, not just a descriptive approach (Evrenius et al., 2007). Because of this, teachers and students are attempting to develop and improve teaching methods for medical education. During the portfolio preparation, students identified the importance of understanding the physiological mechanisms related to the endocrine system. Students also became aware of the importance of integrating physiology and other disciplines in the basic sciences, such as anatomy, biochemistry and cell biology, in order to better understand the functional mechanisms of the human body.

Students had nearly unanimous reactions to the proposal of this assignment with many complaining that the activity would be too laborious, the time would be insufficient for completion and working in groups would cause conflicts. Practically all students discussed their questions within their group members and also consulted with the teacher many times for clarification. The results from previous assignments, where active methodologies were also used in the teaching-learning process, reveal responses that are similar to the ones obtained in the current work (Montrezor, 2014).

In the study of physiology in medical schools, many types of tools for conceptual understanding are used to improve learning. In past teaching programs, students were passive receivers of knowledge, mainly through theoretical courses. However, we now have new methods including active learning forms, especially cooperative ones that have been associated with numerous additional positive effects. These desirable effects are increased student engagement (Smith et al., 2005). Our results confirm that students have identified the value of actively building knowledge using the portfolio as an educational tool. Many studies have demonstrated the efficacy of the portfolio as an evaluation mechanism (Campbell et al., 1996; Kalet et al., 2007; Nagler et al., 2009; Bierer and Dannefer, 2011). The present study did not use the portfolio as an evaluation tool; however, the portfolio was significant as an active methodology in the learning process, especially for the student that did not know they could be allowed portfolio consultation.

Despite the fact the portfolio was not used as an evaluation tool, in this study the students used it as a reference material during the CMT on endocrine physiology. The CMT scores from the students that knew they would be allowed to consult portfolio were below our expectations. Most students scored between 5.0 and 6.9; therefore, even though most students accomplished over 50% of the CMT, we expected higher scores based on the fact that the students could consult portfolio. Because students had been previously informed they would be allowed to use the portfolio as a reference material, we believe most of them did not adequately prepare for the test. The fact students knew they could check the portfolio could have discouraged them to study in advance for the test. It is clear when compared to the students that did not know they would be allowed to consult portfolio as a reference material during the CMT. It is worth mentioning that the answers given by students in the CMT were not incorrect from a technical standpoint, but they were incomplete according to standard.

The utilization of the portfolio was proposed to students before theoretical classes on endocrine system physiology. This teaching strategy to encourage students to develop portfolio before the lectures, in association with the fact that one group of students did not study prior to the CMT, could have contributed to the low scores obtained in the test. However, when theoretical classes occurred after the CMT, we noticed active student participation

similar to the active participation within the groups during portfolio preparation. Classes were conducted in the form of a debate as opposed to the conventional model where the teacher presents the subject while students passively listen. Many studies have indicated that active forms of learning are more effective than the traditional lecture, which is considered to be a more passive form of learning (Bowen, 2000; Knight and Wood, 2005; Armbruster et al., 2009). In particular, the advantages of active learning have been emphasized with regard to conceptual understanding (Smith et al., 2005; Armbruster et al., 2009). Moreover, relative to passive learning, active learning approaches, especially cooperative ones, have been associated with a great number of positive effects. Some of these desirable effects include: increased student engagement (Lord, 2001; Smith et al., 2005; Armbruster et al., 2009), elevated self-confidence and improved self-perceived competence (Lord, 2001; Smith et al., 2005).

Active *versus* passive learning is not a simple dichotomy. A common factor in most articles on active learning is the suggestion that the traditional didactic lecture is more passive in nature and less effective as a teaching tool when compared with active learning methods. Even after the discussion and the exposure of the benefits of portfolio as active methodology some students ($n = 9$ (7.2%)) preferred the traditional teaching methodology where the instructor presents the subject in the form of typical theoretical classes. However, a well-organized lecture remains one of the most effective ways to integrate and present information from multiple sources on complex topics, such as those often encountered in the teaching of physiology (Richardson, 2008).

Healthcare systems in emerging market economies are undergoing economic, political and social transitions. Reforms in the healthcare system need to be complemented by adequate education. The current education system requires updates via need-based comprehensive curriculum design and innovative teaching methods (Nair and Webster, 2010). Brennan et al. (2010) proposed a study to understand how junior doctors' experience the transition from the role of student to that of practicing doctor and how well their medical school education had prepared them. Traditionally, medicine has been a hierarchical profession in which senior doctors wield considerable power over junior doctors (Brennan et al., 2010). Our medical school has a modular and integrated curriculum. From the first year of study, students are encouraged to think in an integrated manner among the basic areas of study and to comprehend the importance of such areas for clinical education. One of the topics included in the cards of the portfolio was the correlation between endocrine system physiology and clinical outcomes. Thus students are encouraged to understand the operation of a normal organism so that they will have the required knowledge to understand the modules where they will learn pathology and clinical issues that may arise from deviations in the normal organ function.

Teamwork is constantly emphasized in our medical school curriculum during numerous educational activities. The importance of teamwork is impressed upon students starting in the first year. For educational activities where active methodologies are applied in the course of physiology, students are often organized in groups randomly, including this current assignment. The importance of working in multidisciplinary teams is constantly explained to students, especially first-year students. Tomorrow's Doctors is an United Kingdom program that emphasizes the importance of working as a team in a multi-professional environment and how medical school should explore and, where appropriate, provide opportunities for students to work and learn with, from and about other health and social care professionals (GMC, 2009). Brennan et al. (2010), showed that such experiences varied greatly in terms of teamwork and the level of support provided.

Finally, one of the portfolio topics required students to search online for incorrect and/or incomplete information about the pro-

posed subject. The goal of this topic was to advise students to be alert and cautious with information obtained from websites that are not scientific in the area of physiology. We know students are frequently connected through their laptops, tablets and smartphones. Therefore, due to the availability of voluminous information on the Internet and the easy and quick access students have to such information through their devices, it is crucial to advise them to use this information carefully beginning in the first-year of medical school. There are excellent quality data available online, but it is important to know where to find such quality information.

We agree with and share the ideas proposed by Volpe (1984), "Public understanding of science is appalling. The major contributor to society's stunning ignorance of science has been our education system. The inability of students to appreciate the scope, meaning, and limitations of science reflects our conventional lecture-oriented curriculum with emphasis on passive learning. The student's traditional role is that of a passive note-taker and regurgitator of factual information. What is urgently needed is an educational program in which students become interested in actively knowing, rather than passively believing". We can come to the conclusion that the use of the portfolio as an active methodology in the teaching-learning process for second-year medical students has encouraged the search for knowledge and has allowed for an active construction for learning about the endocrine system physiology, besides developing in each student the ability to debate and share the knowledge in the group and among groups. At our medical school, we have been working hard to develop a high quality educational approach to form students who are active in the teaching-learning process so that through such practice they can become qualified, competent and fair professionals who are respectful to others.

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